UDOT Report #: UT-97.03

Buttons vs Tape:
Field Performance Study and Research Findings of Alternative Delineator Markers

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Published by:
UDOT Research Division,
Transportation Products Development Group (TPDG)

June 1997

UDOT Research Division
Transportation Products Development Group
4501 Constitution Blvd, Salt Lake City, UT 84119

UDOT RESEARCH & DEVELOPMENT REPORT ABSTRACT

1. Report No. UT-97.03	**2. Government Access #**	**3. Recipient's Catalog #**
4. Title and Subtitle Buttons vs Tape: Field Performance Study and Research Findings of Alternative Delineator Markers	**5. Report Date** June 1, 1997	
	6. Performing Organization Code	
7. Author(s) Basha, Mujeeb A. Sharp, R. Barry	**8. Performing Organization Report #**	
9. Performing Organization Name and Address Utah Department of Transportation 4501 Constitution Blvd. Salt Lake City, UT 84119-14840	**10. Work Unit #**	
	11. Contract #	
12. Sponsoring Agency Name & Address Utah Department of Transportation 4501 Constitution Blvd. Salt Lake City, UT 84119-14840	**13. Type of Report and Period Covered** Internal & External Research Report 1995-1997	
	14. Sponsoring Agency Code	

15. Supplementary Notes

16. Abstract

Following is a technical research report prepared by the research division on the subject of delineator markers and their field performance. This report summarizes a one-year experimental field study conducted with assistance of maintenance division. Performance history is discussed and a draft standard drawing (prepared by traffic and safety division) is submitted for review and discussion.

The purpose for this project was to find a faster and better method to install delineator markers. Further, to find alternative methods of marker installation which would last longer. A literature search was performed to find other significant research on this subject. Also, a nationwide questionnaire survey was solicited. From this research the concept of "target plates" and "target cylinders" was proposed to be installed as an experimental test section. During July 1996 various brands of reflective sheeting and prismatic buttons were installed on I-215 in Salt Lake county and on I-70 in Salina canyon. Performance data was collected and professional opinions taken from maintenance employees. Research recommendations include: (1) use of 4"x4" target plate riveted to post, (2) Contracting with traffic material suppliers to procure sheeting with greater retroreflective specific intensity, (3) use of plastic or metal target plates, (4) Also presented is a standard drawing for target plates, (5) Target cylinders are not recommended for use.

17. Key Words Post-Mounted, Delineator, Tape, Buttons, Prismatic Reflectors, Target Plates, Target Cylinders, Reflective Sheeting		**18. Distribution Statement** UNLIMITED	
19. Security Classification (of this report) UNCLASSIFIED	**20. Security Classification (of this page)** UNCLASSIFIED	**21. # of Pages** 15 pp. Report and 13 pp. Appendices	**22. Price**

TABLE OF CONTENTS

Page

Action Memorandum

State of Utah
Department of Transportation

Research & Development
Transportation Products Development Group (TPDG)

DATE: April 28, 1997

TO: 1997 Maintenance Quality Panel

FROM: Mujeeb Basha, R&D
Barry Sharp, R&D

SUBJECT: Research findings of Buttons vs Tape experimental study.

Executive Summary,

Following is a technical research report prepared by the research division on the subject of delineator markers and their field performance. This report summarizes a one-year experimental field study conducted with assistance of maintenance division. Performance history is discussed and a draft standard drawing (prepared by traffic and safety division) is submitted for review and discussion.

Abstract,

The purpose for this project was to find a faster and better method to install delineator markers. Further, to find alternative methods of marker installation which would last longer. A literature search was performed to find other significant research on this subject. Also, a nationwide questionnaire survey was solicited. From this research the concept of "target plates" and "target cylinders" was proposed to be installed as an experimental test section. During July 1996 various brands of reflective sheeting and prismatic buttons were installed on I-215 in Salt Lake county and on I-70 in Salina canyon. Performance data was collected and professional opinions taken from maintenance employees. Research recommendations include: (1) use of 4"x4" target plate riveted to post, (2) Contracting with traffic material suppliers to procure sheeting with greater retroreflective specific intensity, (3) use of plastic or metal target plates, (4) Also presented is a standard drawing for target plates, (5) Target cylinders are not recommended for use.

cc: Dal Hawks, Program Manager, R&D
Shana Lindsey, Methods Engineer, Maintenance
Dan Julio, Engineer for Maintenance
Fred Lewis, Traffic Operations Engineer
Ross Christensen, Maintenance Engineer, Richfield District

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Introduction

Background Information,

During the December 1995 UDOT Maintenance Quality Panel meeting the subject of "Buttons vs Tape" was brought up by the Richfield office of maintenance.[1] The contention was made that prismatic buttons are faster to attach than reflective sheeting on roadside delineators. Also at that time, durability of buttons was claimed to be better than sheeting, especially in areas where wet and snowy conditions contribute to degradation of the sheeting backing. It was experienced by maintenance forces that before applying a new piece of sheeting great care must be taken to completely remove the old sheeting to insure proper bonding to the metal post. These facts were presented in a brief video produced by the Richfield district maintenance division.

FHWA Guidelines and Definitions [2]*,*

Daytime delineation of the roadside generally can be accomplished effectively with pavement markings. Night visibility, however, often requires a different approach to provide long-range delineation of the roadway alignment. Another problem is providing visibility during periods of rain or snow when most pavement markings are obscured. Post-mounted delineators (PMDs) of various forms have gained widespread acceptance as a roadway delineation treatment. Components of a typical PMD consist of a retroreflective element, the support or mounting post, and possibly a backplate.

The purpose of post delineation is to outline the edges of the roadway and to accent critical locations. The Manual of Uniform Traffic Control Devices (MUTCD) defines these devices as follows: "Road delineators are light-retroreflecting devices mounted at the side of the roadway, in series, to indicate the roadway alignment."

Current State-of-the-Practice

Maintenance Practice,

UDOT specifies either a microscopic glass-bead reflective sheeting or an acrylic lens colored prismatic reflector. Markers are mounted on a metal delineator post weighing 2 lbs/ft of post with seven foot standard length. Currently the Department does not specify use of a target plate for affixing any sheeting prior to attachment to a delineator post.

UDOT Standards,

The 1994 UDOT Standard Specification 811, Delineator Posts, calls for using reflective sheeting described as “encapsulated lens sheeting or encapsulated lens (flexible) as specified” in FP-92 (Type III).[3]

Current UDOT practice for the maintenance of roadside delineators is to affix a 4"x5" applique of 3M brand flexible High-Intensity reflective sheeting directly onto the cleaned surface on the convex side of the U-channel metal delineator post. The standard specification for delineators is given on pages “A-1" to “A-3". Also, The standard drawing depicting details for delineation hardware is found in the appendix on pages “A-4" and “A-5".

Maintenance Cost History,

Historical costs for the maintenance activity identified as “reflector maintenance” were queried in the MMS database. Using Region 1 as a typical example indicates that from 1992-1995 , average yearly costs for this activity were as follows:

Activity Summary Inquiry for
"Reflector Maintenance"
for Region 1 from 1992 to 1995

	Average cost/yr
Labor =	$76,330
Equip. =	$9,160
Matls. =	$27,830

(Source: UDOT MMS)

From this data we see that reflector maintenance can be a significant cost burden to the maintenance budget when considering statewide needs. Please note that these costs are provided as informational only. Because of the variable nature of reflector maintenance, total item life-cycle costs cannot be accurately tracked; however, an attempt to ascertain a quasi-life cycle cost benefit is presented in the last section of this report in the form of new product recommendations.

Materials costs for an individual piece of 4"x5" reflective sheeting applique is currently $0.63 per each. Costs for delineator buttons is $0.31 per each prismatic button plus the cost of the rivets used for attaching the button.[4]

Post Mounted Delineation (PMD) Performance

On-going Experimental Test,

A seven-mile experimental test section of metal-backed prismatic reflector buttons was installed in February 1996 on I-80, Parley's Canyon, from MP 140.0 to 147.0 both east- and west-bound. An interim field visit to assess the condition of the reflectors was made in April 1996. *It was found that about 17% of these prismatic buttons were damaged or broken during this three month time period.* Most damage could be directly attributed to snowplow activity. Some damage may be attributed to vehicle-delineator accidents. Records of delineator accidents indicate that at this particular location there were 3 incidents in 1992, 4 incidents in 1993, and 4 incidents in 1994 where delineators were damaged.[5] Besides reflectors being shattered it was found that many delineators posts were twisted or bent down.

Prismatic Buttons,

Prismatic buttons generally have brighter retroreflectivity when compared to reflective sheeting. However, for prismatic reflectors to function properly the "observation angle" of the driver with respect to the reflector is quite narrow when compared to glass-bead reflective sheeting. *(Please see appendix page "A-6" and "A-7" for comparison of minimum entrance angles and observation angles)*. For this reason the UDOT division of Traffic and

Safety does *not* recommend use of prismatic buttons and prefers the use of reflective sheeting exclusively. The maintenance division prefers using buttons because of the ease of installation of these devices.

Reflective Sheeting,

As mentioned previously reflective sheeting applied directly to metal delineator posts have not been found to last as long as expected. Reasons for poor performance have been due to water entering the edges and back of the sheeting causing adhesion failure. Also, snowplow damage and vehicular accidents may cause posts to bend or twist; however, in these situations the retroreflective qualities of the sheeting are intact and it can still be spotted by a nighttime driver even at severely obtuse observation angles.

National Survey

Technical Questionnaire,

As an effort to research more about current delineation practices a questionnaire was sent to every State. This survey was faxed to traffic and maintenance operation engineers asking impartial questions about their methods for roadside delineation. Twenty-nine states responded to the survey. Three target questions were asked:

What type(s) of roadside delination markers do you currently specify on State routes?

- reflective sheeting
- prismatic reflectors
- other

What method do you use for fastening the reflective marker to the delineator post?

- apply sheeting directly to post
- rivet reflector to post
- apply sheeting to substrate, then rivet to post
- other method

What reason(s) does your Agency have for using one type

of marker over another?

- ‘ costs less to use _____ type marker.
- ‘ life expectancy greater for this type marker.
- ‘ serviceability is easier for maintenance.
- ‘ availability of product.
- ‘ no specific reason why one is used over another

Besides these questions, respondents were asked for a copy of their most current Standard Drawing and/or Specification for roadside delineation markers and posts. Most States returned a copy of these design documents. Also, they were asked to provide a contact person for any detailed technical information.

A copy of the original questionnaire is found in the appendix on page “B-1". For the three questions above, the results in the form of a simple frequency distribution pie chart are in the appendix on pages “B-2" to “B-4".

Survey Results,

In summary, from these charts we find that most States...:

- prefer “both, sheeting and buttons” or “just reflective sheeting” as delineation options.
- either “rivet” or “bolt” a piece of sheeting on substrate directly to the post.
- find sheeting of “greater value” when compared to prismatic reflectors.

PMD Alternates: New Technology and Products

Target Plates and Cylinders,

From the technical survey it was found that many states use the concept of a metal or plastic target plate with a piece of flexible reflective sheeting adhered to it. An alternate method is to use a PVC pipe (cylinder).

Target plates are used on tangent roadways while cylinders are used on sharp curves and

on- and off-ramps. The cylinders provide greater reflective angularity in curve sections. These target plates and cylinders are either bolted or riveted onto the delineator post. *A typical example of each is detailed on the next page.*

Typical Cost of Materials,

Most States either make the target plates and cylinders in-house or they contract them out to local materials suppliers or correctional facilities for manufacturing. By way of example, Arizona DOT procures 4"x4" aluminum target plates at $0.65 per each from Vulcan Aluminum of Alabama. They have a contract with 3M company for purchasing flexible high-intensity sheeting at $0.60 per each applique. They affix the sheeting to the plate in-house. They purchase 6" long x 3.5" diameter PVC cylinders with sheeting wrapped around the cylinder from Arizona Correctional Industries for $1.20 per each.

Proposal for New Product Testing,

Rather than arbitrarily accepting this researched concept for delineation markers, it was recommended to the 1996 Maintenance Quality Panel to perform an experimental field test of different types of delineator targets. The field experiment would evaluate their practicality, ease of installation, performance, durability, ease of replacement, worthiness when bent or twisted, retroreflective performance, and other evaluation parameters as needed.

A proposal “Research Construction Work Plan” is attached in the appendix on page “C-1" outlining objectives, location, estimated time and cost to complete, and a data collection and evaluation plan.

Field Research Evaluation Program

Experimental Test Objectives,

The purpose of this experimental feature was to compare the existing methods of delineator hardware and to try alternate methods as recognized by the research draft report published by R&D in May 1996. Research goals for this experimental test section included the following evaluation criteria: durability through seasons, marker mortality rate, ease of replacement, time expended to install, maintenance life-cycle costs, retroreflective performance, and professional opinion from maintenance personnel.

Experimental Test Location,

Test Site #1: Urban interstate,

On I-215 from 5900 South (Exit 13) to 4700 South (Exit 15), northbound, near the UDOT/DPS Calvin Rampton Complex. Approximately a two-mile curvilinear segment of roadway and P-ramp at interchange Exit 15 on this urban interstate.

Test Site #2: Rural interstate,

On I-70 in Salina canyon, westbound. Approximately a three-mile segment located in a high wind and extreme snow envrionment in canyon and high elevation environment on this rural interstate.

Construction Installation Schedule,

UDOT Research staff and Region 2 and Salina Maintenance crews installed seven different "methods" for post-mounted delineation markers. Following is a schedule of test subsections used for comparative evaluation:

â AKT plastic-backed buttons

ã 3M Hi-Intensity (3870) sheeting directly to metal post

ä AKT metal-backed buttons

å 3M Diamond grade (3970) sheeting on aluminum plate

æ Stimsonite metal-backed button

ç 3M Hi-Intensity sheeting on aluminum plate

è Stimsonite 6200 Series sheeting on aluminum plate

é Target cylinder with 3M Hi-Intensity sheeting wrapped

Test subsections and field data collected are identified on page "C-2" of this report.

Summary of Field Test Findings:

Retroreflective performance,

Retroreflected light is defined as the light which travels from a vehicles headlights and strikes a reflector ("entrance angle") and is reflected back to the driver's eyes ("observation angle"). Some factors that degrade the retroreflectance of sheeting or buttons with time, are weathering, sun (UV radiation), repeated freezing and thawing, and abrasion caused by blowing dust and sand. *In general, the prismatic reflectors had brighter retroreflectivity when compared to any of the reflective sheeting products. The glass-bead versus the micro-prismatic sheeting when compared to each other show no real observable differences in retroreflectivity.* The claimed values of initial specific intensity from manufacturers literature would indicate the products rank in the following order for retroreflective specific intensity, R_A :

			Specific Intensity [mCd/Lux/15 sq in]			
Brand / Type	**Obs Ê**	**Ent Ê**	**White**	**R_A rank**	**Yellow**	**R_A rank**
3M, Reflective High Intensity Grade	0.2E	! 4E	2420	4	1640	4
" " " "	0.2E	+30E	1450		960	
3M, Diamond Grade (LDP)	0.2E	! 4E	7770	2	6380	2
" " " "	0.2E	+30E	3870		3290	
Stimsonite, Series 6200 Hi-Performance	0.1E	! 4E	7000	3	5000	3
" " " "	0.1E	+20E	4200		3000	
AKT/Stimsonite, Acrylic Lens Reflectors	0.1E	0	11070	1	6600	1
" " " "	0.1E	+20E	4380		2600	

The value of specific intensity, R_A, is discussed because the PMD marker is used as a "point" light source. Acrylic plastic lenses rank first place for specific intensity, but are not reliable for long-term field performance. The chart above gives specific intensity for 15 sq. in. area shown. The recommended size for the target plate is 4"x4" square, which would provide 16 sq. in. of total reflected area.

Time Study Results,

Time spent during installation for each PMD method was documented. It was originally reported by the Richfield maintenance shed that to completely remove old sheeting and apply a new piece would take about 5.5 minutes. Also, it was reported that a prismatic button could be installed with a rivet gun in 0.5 minutes. From field time studies *the scrape-and-replace method was found to be just as fast as the riveting method of installation*. No tangible time/ cost benefit could be found. Field data was collected in July 1996 and is found in the appendix on page C-2. Field data includes a description of the method, number of replicates per test section and the actual time spent for the activity.

Measurements of this activity for a two man crew, one to drive from post-to-post and one to perform the actual labor, show that the average time for installation as follows:

Description of Method	**Time Spent (minutes/post)**	**"Similarity" Code**
â AKT plastic-backed buttons	1.7	•
ã 3M Hi-Intensity (3870) sheeting directly to metal post	1.4	
ä AKT metal-backed buttons	1.9	•
å 3M Diamond grade (3970) sheeting on aluminum plate	1.1	
æ Stimsonite metal-backed button	1.2	•
ç 3M Hi-Intensity sheeting on aluminum plate	1.3	
è Stimsonite 6200 Series sheeting on aluminum plate	1.4	
é Target cylinder with 3M Hi-Intensity sheeting wrapped	1.8	~

Another way of looking at this time data is to calculate a composite value by “similarity” code. The activities which are similar are averaged and are presented in terms of number of markers installed per hour. These values are as follows:

Activity	“Similarity” Code	Ave. Time Spent (min/post)	*Number of markers / Hr*
applying sheeting directly to post		1.4	***43***
target plate riveted to post		1.3	***46***
prismatic button riveted to post	•	1.6	***38***
target cylinder riveted to post	~	1.8	***33***

Durability Characteristics & Mortality Rates,

This topic is closely related to retroreflective performance, discussed above, but goes further in characterizing overall performance of the adhesion, substrate, and the attachment methods. Evaluation of the test sites at both Salt Lake county and in Salina canyon show that the 3"x5" target plates which were riveted tended to rotate. For aesthetic reasons it would be better to have used a 4"x4" target plate which if rotated would not be as unsightly. Also, the 4"x4" plate would have 1 square inch greater area for “point” retroreflectance. The prismatic buttons were prone to shattering, especially in the urban environment. The intense wind and snow in Salina canyon quickly made holes in the sheeting which was applied directly to the post. The target plates performed consistently best of the three methods used.

Another test deck is the culvert markers which have been used extensively in the southern region. These culvert markers are basically target plastic plates with 3M high-intensity sheeting on plastic plates which are riveted to a delineator at culvert crossings. The sheeting on these culvert markers are performing “excellent” and have far exceeded maintenance division expectations. *The long-term performance of target plates may be justified when considering culvert markers performance history.*

Life Cycle Cost Comparison,

It is extremely difficult to make a "true" life cycle cost comparison due to the varying nature of delineator maintenance and the many environmental variables. Nevertheless, here an attempt is made at comparing methods while taking into account the safety issues, future maintenance labor issues, as well as quasi-life cycle costs.

The following table lists the quasi-life cycle costs and some tangible benefits for the three major marker methods:

Method	Cost ($/each)	Predicted Life	Quasi-Life Cycle Cost	Other Tangible Benefits
existing sheeting (4"x5")	$0.63	1 yrs	$0.63/each /yr	• sheeting flexibility withstands environmental abuse • provides full retroreflectivity even at obtuse observation angles.
button + rivet	$0.33	3 yrs	$0.11/each /yr	• easily installed with rivet. • removal with hammer. • excellent retroreflectivity if perpendicular to traffic.
target plate + rivet	$0.68	7 yrs	$0.17/each /yr	• installed with rivet. • removed with hammer. • full retroreflectivity at obtuse angles. • longest predicted life expectancy. • man-hour savings over seven yrs.
reflective sheeting (4"x4")	$0.53			

From this table it appears that in terms of quasi-life cycle costs, "buttons" are the most cost-effective, plus they provide the best retroreflective brightness. However, the fact remains that for bent or twisted delineators the buttons are rendered useless. Taking the tangible elements into account it is recommended to pursue a change in specification to adopt the target plate method with some type of reflective sheeting, preferably the brightest specific intensity sheeting. Long-term benefits of target plates are that they are reusable. When the sheeting is blistered, peeling back, etc., the other side of the plate can be used as a "recycled" product; buttons and just sheeting don't have that advantage.

Maintenance Professional Opinion,

Salina maintenance shed found the target plate method to be just as effective as the riveted buttons for installation. They found that the target plates are holding up better than the existing method. Also, they found that the buttons have greater retroreflective brightness than any of the various sheeting products. The only caveat to riveting plates is that spacing washers may need to be used and/or smaller rivets need to be in inventory for this work. Also, it was found that two people are needed for efficient installation. One person to hold the plate in position and one to rivet the plate. Also, it would be recommended to use two people for this activity for worker safety since the installer's back is to traffic when riveting a target plate onto the delineator. Industrial quality rivet guns are recommended to be purchased since this activity would require hundreds of delineators to be maintained. Target cylinders were found to be difficult to install because of the space limitations between the inside of the cylinder and the post itself.

Performance Test Conclusion and Recommendations,

The purpose for this project was to find a faster and better method to install delineator markers. Further, to find which method of marker installation would last longer than the current method. It was recognized that prismatic buttons have brighter retroreflection. However, they do not provide adequate retroreflective qualities when damaged or at obtuse observation angles such as when bent or twisted. A literature search was performed to find other significant research on this subject. Also, a nationwide questionnaire survey was completed. From this research the concept of "target plates" and "target cylinders" was proposed to be installed as an experimental test section. During July 1996 various brands of reflective sheeting and varieties of buttons were installed on I-215 in Salt Lake county and on I-70 in Salina canyon. Performance data was collected and opinion polls taken from maintenance employees.

Following are recommendations of the research conducted discussed herein:

- Adopt 4"x4" target plate and rivet with reflective sheeting for delineator markers.

- Contract with traffic material suppliers to provide target plate with reflective sheeting affixed and with hole drilled for a rivet.

- To help control material costs, solicit bids for either plastic target plates or aluminum target plates. Procure whichever material gives the lowest bid.

- To further control material costs and to encourage market diversity in reflective sheeting, solicit bids to include alternative sheeting which meets minimum “specific intensity” requirements for delineation applications.

- Do not use target cylinders since they are cost prohibitive as well as difficult to install.

- Use industrial quality rivet gun and aluminum rivets which match the target plate thickness and do not require spacing washers.

- Discontinue practice of acrylic lens prismatic reflectors and the practice of affixing flexible sheeting directly to post due to poor performance history.

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UDOT Development Engineer
Research Author

R. Barry Sharp
UDOT Research Specialist
Research Co-Author

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ENDNOTES

[1] "Buttons vs. Tape" technical report and video produced by Richfield Maintenance Crew in Richfield, UT. (Fall 1995). Presented to the December 1995 Maintenance Quality Panel meeting in Richfield.

[2] Excerpted from Roadway Delineation Practices Handbook, James Migletz, Joseph Fish, and Jerry Graham. Published by FHWA as Report No. FHWA-SA-93-001 (August 1994); pages 5-17.

[3] Excerpted from "1992 FHWA Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects". Published by FHWA as document FP-92. Section 718.12 on Delineator and Objectg Marker Retroreflectors. Pages 650-651.

[4] Found in the UDOT Maintenance Management System (MMS) database under materials descriptions "DEL TAPE, AMBER III#3811 4"X5"" and "DELINEATOR BUTTON AMBER 3 1/4". Information courtesy of David Stanworth, Central Maintenance division.

[5] Data found in UDOT "Quicklisting for Delineator Accidents from 1992-1994" published by UDOT division of Traffic and Safety.

BIBLIOGRAPHY

Utah Department of Transportation "1994 Metric Standard Specification", UDOT Construction Division, 4501 Constitution Blvd., Salt Lake City, UT 84119-5998.

Utah Department of Transportation "1994 Metric Standard Drawings", UDOT Construction Division, 4501 Constitution Blvd., Salt Lake City, UT 84119-5998.

American Society for Testing and Materials (ASTM) D 4956-94, "Standard Specification for Retroreflective Sheeting for Traffic Control". 1916 Race St., Philadelphia, PA 19103.

APPENDIX "A"

APPENDIX "B"

B-1.....Technical Information Questionnaire about "Roadside Delineation"

B-2.....Simple Frequency Distribution Pie Chart for Question #1:
"What type of delineation markers?"

B-3.....Simple Frequency Distribution Pie Chart for Question #2:
"What method for fastening?"

B-4.....Simple Frequency Distribution Pie Chart for Question #4:
"Reasons for using one marker type over another?"

APPENDIX "C"

C-1....."Construction Work Plan" for X-File, Experimental Field Evaluation.

C-2.....Field data collected from installation time study performed in S.L. County.

UTAH DEPARTMENT OF TRANSPORTATION **X-File # _____**
Technology & Product Development Group

CONSTRUCTION WORK PLAN
Effectiveness of Post-Mounted Delineation Markers

Problem Statement:

Metal roadside delineator posts have either reflective sheeting or prismatic reflectors affixed to the post. The durability of prismatic buttons have been found by Maintenance crews to be better than reflective sheeting, especially in areas where wet and snowy conditions prevail. However, retroreflective characteristics of sheeting are superior when compared to buttons. Herein lies the problem: developing a better method for maintenance of roadside delineation while preserving nighttime safety. A nationwide survey of DOTs was conducted to determine alternate methods for markers. A common solution in most States is to use the concept of "target plates and cylinders". Basically, what is done is to affix a piece of sheeting to an aluminum or plastic target plate and rivet or bolt that unit to the delineator post. Costs for these units are about double the current materials costs. Findings from preliminary research were presented at the May 1996 UDOT Maintenance Quality Panel, Park City, UT. A recommendation for a two-year field evalualation was proposed and accepted by the panel. This research study is the result of that recommendation.

Objectives:

To compare the existing methods of delineator hardware and to try alternate methods as recognized by the research draft report published by R&D in May 1996. Research goals for this experimental test section will include the following evaluation criteria: durability through seasons, marker mortality rate, ease of replacement, time expended to install, maintenance life-cycle costs, retroreflective performance, worthiness when posts are bent or twisted, subjective public opinion of marker effectiveness.

Location:

Test Site #1: Urban interstate,
On I-215 from 5900 South (Exit 13) to 4700 South (Exit 15), both east- and west-bound, near Calvin Rampton Complex. Approximately a two-mile curvilinear segment of roadway and P-ramp at Exit 15 on this urban interstate.

Test Site #2: Rural interstate,
On I-70 three miles east of Salina Exit 54, both east- and west-bound. Approximately a three-mile tangential segment with interchange at Exit 54 on this rural interstate.

Materials and Suppliers:

Prismatic Reflectors,

AKT Corporation — **Aluminum-Backed Reflector**
906 Morse Avenue
Schaumburg, IL 60193
(708)428-3181

Refective Sheeting,

Stimsonite Corporation — **Series 6200 Sheeting**
Attn: Kirk Brunton
5010 Paseo De Pablo
Torrance, CA 90505
(310) 375-1954

3M Company, TCM Division — **Hi-Intensity & Diamond Grade Sheeting**
Attn: Dennis Johnson
Bldg 225-5F-08
PO Box 33225
St. Paul, MN 55144-3225
1-800-553-1380

Target plates and cylinders,

Arizona Correctional Industries — **PVC Target Cylinder w/ Hi-intensity sheeting**
Attn: Bill Bachman
1918 West Van Buren
Phoenix, AZ 85009
(602) 255-1464

Davidson Plastics — **Plastic Target Plate Blanks (& w/sheeting)**
Attn: Tanya Bakholdin
18726 East Valley Hwy
Kent, WA 98032
(206) 251-8140

Vulcan Aluminum — **Aluminum Target Plate Blanks**
Attn: Todd Konier
PO Box 1850
Foley, AL 36536
1-800-633-6845

Construction Installation Schedule:

UDOT Research staff and Region 2 and Richfield Maintenance crews will install seven different "methods" for post-mounted delineation markers. Following is a schedule of test subsections needed for comparative evaluation:

â AKT prismatic reflectors.
ã 3M Hi-intensity sheeting directly to post.
ä Stimsonite Series 6200 sheeting directly to post.
å 3M Hi-intensity sheeting on PVC target cylinder.
æ 3M Hi-intensity sheeting on aluminum target plate.
ç 3M Diamond-grade sheeting on plastic target plate.
è Stimsonite 6200 Series sheeting on plastic target plate

Test subsections are identified on the location map on the last page of this report

Test sub-sections will have 10 replicates of each method at each test site. Thus, the test section will be about 5 miles (8 Km) in total length.

Personnel Used & Report of Findings:

On Personnel,
Research staff, Richfield and Region 2 maintenance crews will be used during the construction installation. Research staff will perform field interim evaluation visits.

On Reports,
A memorandum will be delivered regarding installation time spent for each "method" in August 1996. Six-month interim reports will be written and kept on file. A final report will be published in Spring 1997. Also, at that time a recommendation for change in Standard Specification and Standard Drawing will be proposed. An addendum report will be published in Spring 1998 of long-term effects on the PMD markers and revised life-cycle costs.

Field Research Evaluation Program:

Retroreflectivity performance of products,
Retroreflective performance is a critical factor and will measured for each subsection. Retroreflectivity values of each PMD marker will be noted from trade literature. A visual comparative test will be conducted during nighttime, rain, and snowy conditions to subjectively compare the buttons and the three different varieties of tape. Distances will be measured when retroreflectivity begins. These distances will be published in the final report.

Installation time by method,
The install time has been deemed an important practical factor by the maintenance division. For 20 replicates, in subsections ð and ñ, measurements will taken of the time spent to scrape off old sheeting and apply new sheeting to a post. For 10 replicates, in subsection ï, the time to remove damaged buttons and install new buttons will be measured. Also, for 20 replicates, in subsections ô and õ, the time spent to install twenty typical target plates will be measured. Man-hours per device times will be noted and reported in the form of a memorandum after the test section is installed in July 1996. Please note that this "time factor" should not be considered the guiding force to change our current specification as a proper evaluation period is necessary to fully understand the effects on each product under real-life conditions.

Durability characteristics and mortality rates,
The durability of each subsection will be monitored at 6-month intervals. General observations will be noted regarding PMD marker condition, mortality rates, effects from the seasonal elements, effects from snowplow activity. These observations will be noted at 6-month intervals in the form of interim reports and will be published in the final report and long-range addendum report.

Life-cycle cost comparison,
Current item costs will be noted for each product. Mortality rate will be measured at 6-month intervals and used for life-cycle cost estimates. Recyclability of product will be considered if their is cost benefit. Maintenance man-hour saved will also be used in the life-cycle cost estimate. These results will be published in the final report and also in a long-range addendum report.

Ease of maintenance and professional opinion of "methods",
Personal interviews will be conducted with maintenance crews in Richfield district and Region 2 to ascertain how user-friendly each type of marker method is found to be. These comments will be duly noted and used in the final recommendation for proposal for change in specification and standard drawings. Comments will be published in the final report.

Mujeeb A. Basha
Development Engineer

R. Barry Sharp
Research Specialist

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FIELD DATA (07/17/96 & 07/18/96)

Installed by: M. Basha, B. Sharp, D. Debenham, L. Crane
Data collected by: M. Basha, B. Sharp

I-215, West side, N-bound from MP 13.5 to MP 16.0, left side *(Yellow markers)*				
#	**Description**	**Replicates**	**Time spent**	**Comments**
1	AKT plastic-backed buttons	6 each	10:00 min.	
2	3M Hi-Intensity on metal delineator	10 each	14:00 min.	Control section.
3	AKT metal-backed buttons	5 each	9:30 min.	Rivets did not fit well.
4	3M diamond grade on plate	10 each	11:00 min.	
5	Stimsonite button	10 each	12:00 min.	
6	3M Hi-Intensity on plate	10 each	12:30 min.	
7	Stimsonite 6200 Series on plate	10 each	14:00 min.	
8	Target cylinders on P-ramp.	40 each	60:00 min.	4700 So., E-bound to I-215 N-bound.
9	Target cylinders at on-ramp.	20 each	40:00 min.	4700 So., W-bound to I-215 N-bound.

I-215, West side, N-bound from MP 13.5 to MP 15.5, right side *(White markers)*				
#	**Description**	**Replicates**	**Time spent**	**Comments**
1	AKT plastic-backed buttons	6 each	10:00 min.	
2	3M Hi-Intensity on metal delineator	10 each	15:00 min.	Control section.
3	AKT metal-backed buttons	5 each	3:30 min.	Needed longer rivets.
4	3M diamond grade on plate	9 each	7:00 min.	
5	Stimsonite button	10 each	8:30 min.	
6	3M Hi-Intensity on plate	10 each	12:00 min.	
7	Stimsonite 6200 Series on plate	10 each	13:00 min.	